COMPRESSOR WHEEL ASSEMBLY

This invention relates to the assembly of a compressor wheel to a rotating shaft. In particular, the invention relates to the compressor wheel assembly of a turbocharger.

Turbochargers are well known devices for supplying air to the intake of an internal combustion engine at pressures above atmospheric (boost pressures). A conventional turbocharger essentially comprises an exhaust gas driven turbine wheel mounted on a rotatable shaft within a turbine housing. Rotation of the turbine wheel rotates a compressor wheel mounted on the other end of the shaft within a compressor housing. The compressor wheel delivers compressed air to the intake manifold of the engine, thereby increasing engine power. The shaft is supported on journal and thrust bearings located within a central bearing housing connected between the turbine and compressor wheel housings.

A conventional compressor wheel comprises an array of blades extending from a central hub provided with a bore for receiving one end of the turbocharger shaft. The compressor wheel is secured to the shaft by a nut which threads onto the end of the shaft where it extends through the wheel bore, and bears against the nose end of the wheel to clamp the wheel against a shaft shoulder (or other radially extending abutment that rotates with the shaft).

Modern demands on turbocharger performance require increased airflow from a turbocharger of a given size, leading to increased rotational speeds, for instance in excess of 100,000 rpm. To accommodate such high rotational speeds the turbocharger bearings, and thus the turbocharger shaft diameter, must be minimized. However, the use of a relatively small diameter shaft is problematical with the conventional compressor wheel mounting assembly. That is, it can be difficult to machine a sufficiently narrow bore through the compressor wheel to the required degree of accuracy (the bore must be concentric about the axis and rotation of the wheel if the wheel is to be rotationally balanced). As the diameter of the bore reduces there is a corresponding reduction in the size, and therefore strength, of the tool required to machine the bore. Even where the required accuracy is achievable,

increased machining time and tool wear issues may prevent the process from being economically viable.

The above problem is exacerbated as continued turbocharger development requires the use of higher performance materials, such as titanium, which are even harder to machine than the aluminium alloys conventionally used.

One possible way of avoiding the above problem is to use a so-called 'bore-less' compressor wheel such as disclosed in US patent number 4,705,463. With this compressor wheel assembly only a relatively short threaded bore is provided in the compressor wheel to receive the threaded end of a shortened turbocharger shaft. However, such assemblies can also experience balancing problems as the threaded connection between the compressor wheel and the shaft, and the clearance inherent in such a connection, may make it difficult to maintain the required degree of concentricity.

It is an object of the present invention to obviate or mitigate the above problems.

According to the present invention there is provided a compressor wheel assembly comprising a compressor wheel mounted to a rotating shaft, the shaft extending through a bore provided along the rotational axis of the wheel, wherein the bore has a first axial portion corresponding in diameter to the diameter of the shaft, and a second axial portion of enlarged diameter, such that the inner surface of the second portion of the bore is radially spaced from the shaft.

The wheel is supported on the shaft by the first axial portion of the bore only. This portion of the bore can be machined to the required diameter along the length of the wheel axis over which the required degree of accuracy can be readily maintained. The remainder of the bore is simply enlarged so that it will not interfere with the concentric mounting of the wheel on the shaft.

The invention also provides a turbocharger comprising a compressor wheel assembly as defined above.

Other preferred features of the invention will become apparent from the description below.

Specific embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is an axial cross-section through a conventional turbocharger illustrating the major components of a turbocharger and a conventional compressor wheel assembly; and

Figure 2 is a cross-section through a compressor wheel assembly in accordance with the present invention.

Referring first to figure 1, this illustrates the basic components of a conventional centripetal type turbocharger. The turbocharger comprises a turbine 1 joined to a compressor 2 via a central bearing housing 3. The turbine 1 comprises a turbine housing 4 which houses a turbine wheel 5. Similarly, the compressor 2 comprises a compressor housing 6 which houses a compressor wheel 7. The turbine wheel 5 and compressor wheel 7 are mounted on opposite ends of a common shaft 8 which is supported on bearing assemblies 9 within the bearing housing 3.

The turbine housing 4 is provided with an exhaust gas inlet 10 and an exhaust gas outlet 11. The inlet 10 directs incoming exhaust gas to an annular inlet chamber 12 surrounding the turbine wheel 5. The exhaust gas flows through the turbine and into the outlet 11 via a circular outlet opening which is co-axial with the turbine wheel 5. Rotation of the turbine wheel 5 rotates the compressor wheel 7 which draws in air through axial inlet 13 and delivers compressed air to the engine intake via an annular outlet volute 14.

Referring in more detail to the compressor wheel assembly, the compressor wheel comprises a plurality of blades 15 extending from a central hub 16 which is provided with a through bore to receive one end of the shaft 8. The shaft 8 extends slightly from the nose of the compressor wheel 7 and is threaded to receive a flanged nut 17 which bears against the compressor wheel nose to clamp the compressor wheel 7 against a thrust bearing and oil seal assembly 18. Details of the thrust bearing/oil seal assembly may vary and are not important to understanding of the compressor wheel mounting arrangement. Essentially, the compressor wheel 7 is prevented from slipping on the shaft 8 by the clamping force applied by the nut 17.

Problems associated with the conventional compressor wheel assembly described ab ve are discussed in the introduction to this specification.

Figure 2 illustrates a compressor wheel assembly in accordance with the present invention. Details of the shaft 8, thrust bearing and seal assembly 18, and clamp nut 17 may be entirely conventional, as for instance illustrated in Figure 1.

Where the present invention differs significantly from the prior art assembly of Figure 1, is that the bore through the compressor wheel is radially stepped so that it has two different diameter axial portions 21 and 22. The first axial portion 21 has a relatively small diameter corresponding to the outer diameter of the shaft 8. However the second axial portion 22 has an enlarged diameter so that its inner surface is radially spaced from the shaft 8. The compressor wheel is thus supported on the shaft 8 along the length of the first portion 21 of the bore only. The enlarged portion of the bore 22, is formed in the nose region of the wheel where wheel stresses are lower and thus does not adversely effect operation of the wheel.

Thus, in accordance with the present invention a relatively small diameter bore, of a diameter required to match the shaft 8, is machined in to the compressor wheel to a maximum length which is shorter than the axial length of the wheel at its axis, but which can be readily machined with the required accuracy. The through bore is then completed by machining the enlarged diameter second portion in the nose region of the wheel. Problems encountered in the prior art with attempts to machine a relatively small diameter bore through the full width of the compressor wheel are thus overcome.

It will be appreciated that the enlarged diameter portion 22 of the bore may be machined before or after the small diameter portion 21. Similarly, a small diameter bore could be machined right through the wheel and then enlarged over a portion of its length.

It will be appreciated that modifications may be made to the detail of the embodiment of the invention described above and illustrated in Figure 2. For instance, the relative lengths of the first and second portions of the bore may differ from that illustrated. Also, the bore need not be abruptly stepped in diameter but could have a region of gradually increasing diameter between the first and second portions.

As a further modification a cylindrical sleeve may be fitted in to the relatively large diameter portion of the through bore, the sleeve having an inner diameter matching the diameter of the wheel to provide further support for the wheel on the shaft.

Other possible modifications will be readily apparent to the skilled person.